tectural composition.

DIVISION II. PROPORTIONS IN ARCHITECTURE.

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42. General.

Laws in architecture assure the beauty of the ddifice, just as this is lessened by neglecting them. To seek and to formulate these principles is a problem that science cannot neglect. We endeavor to find and justify its solution, the direct result of esthetic feeling. As for proportion, it is certain and beyond all dispute, that parts of a building must bear a proper relation to each other and to the whole. How may this relation be stated, can it be expressed by numbers, or referred to simple geometrical figures?

Relations of harmonious tones in music have been definitely arranged in numbers. Different tones have different numbers of vibrations. Tones harmonize when their vibrations coincide or accord. Physicists have discovered a similarity in the effect of colors on the eye. But to deduce from this that the eye prefers certain simple ratios of magnitudes in proportions and forms is an error, upon which numerous theories have already been wrecked. For if two tones harmonize together and one be then slightly raised or lowered, the drum of the ear is set into complex or irregular vibrations, producing a discord. But if a rectangle has its sides in proportion of 2 to 3, and its length be then slightly changed, the eye cannot perceive the change. Simple numerical ratios certainly participate in the proportions of ancient edifices. Much talent and labor have ~~been~~ expended in fruitless attempts to discover simple numerical ratios to serve as a basis of the three dimensions in space of an architectural structure. Only a few points can be given here. Henszelmann came to the conclusion that harmony of proportions in the architectural monuments of antiquity were neither result of artistic genius nor merely accidental. He beleived that he found the secret of the ancient ar hitects in the use of the ratio of the side to diagonal of a square, and that of side t diagonal of a cube, and with these magnitudes constructed a scale, for all dimensions of a building. Viollet-le-Duc believed that ancient architects employed three different triangles as bases of proportions; the Egyptian triangle (of the Pyramids), the right angled with equal angles, and the equilateral. But the manner in which these figures are combined on the Arch of Titus at Rome and on the section of the Cathedral at Amiens is not convincing.

We may say that these elements do not holg good so far. If the law

of beauty exists in them, architecture would be condemned to monotony. The massive and bold is justified as well as the slender and graceful. Different characters have each their peculiar beauty in nature, as in this. We seek a law tolerating variety of forms and maintaijing itself under the most diverse conditions.

43. Similarity of Figures.

A stap toward the discovery of such a law was taken when Zeising treated of the golden mean, the fixed ratio that Euclid taught, when the smaller portion of a straight line has to the larger the same ratio as of that to the whole. Its applicatioj to architecture is defective, since the relative proportions have no intelligible relations to each other. But we will accept the idea and proceed further. The fixed ratio is general, as well as similarity of figures. By study of the most successful works in all periods, we fijd a basal form repeated in each edifice, and that different parts always form figures similar to each other in arrangement and form. Innumerable different figures or simple forms of masses may in themselves be termed neither beautiful nor ugly; combined arrangements are alone beautiful. Harmony first arises from repitition of the primary form of the structure in its sub-divisions. This intimate relation of individual members to the whole is especially observed in works of classic architecture and on it is based their united and harmonious appearance.

Chapter 1. Proportions in Doric Architecture.

44. The Doric Temple.

If this be true, it most appear most clearly in Doric temples, whose proportions were employed unchanged for a century. Such complete harmony of all parts was not produced elsewhere than in the columnar construction of the Grecian Doric temple. Fixed ratios were not established, but from the oldest heavy monuments at Selinus to the elegant marble temples in Attica, with firm adherence to the general arrangement and the details, we find a variation in proportions, at the first view a defect. The ratio of length to breadth of the temple, of diameter of column to its height, of height of entablature to height of column, etc., continually vary, but with few exceptions nearly every building retains harmony in its parts, presenting a harmonious effect, complete in itself. Two peculiarities are found: 1, very simple numerical ratios are used for certain parts of the building, later dissapearing in artistic temple architecture and giving place to complex ratios; 2, similarity of geometrical forms of all analogous parts, which is retained as a leading idea until later antiquity.

45. Numerical Ratios.

The following simple numerical ratios are retained in the ancient temples.

Width and height of the cell are equal, as well as those of the pronaos.

2. Width and height of the facade of the cell, so far as externally visible, are to each other as 3 to 2. (Figs. 1,2,7)

3. Height of the columns equals twice the distance between their axes (h = 2a)

4. Height of the architrave equals one-third the distance between axes of columns, or of length of architrave blocks.

The first requirement is satisfied when height of the pronaos to the top of architrave, or to ceiling beams, equals distance between the antae or walls. (Figs. 2,5). An intention is evident to strictly retain ratio of height to width of cell of the temple in the colonnade of the facade. The four middle columns are so placed before the cell that the outer axes coincide with the external width of the cell. (Figs. 2,4,7, 9,10). With the entablature above it, this portion of the columnar facade always forms a rectangle, closely approximating to a square, Semper's unit;

$$\text{which} = \frac{\text{Height of column with entablature.}}{\text{Three times distance between axes.}}$$

Since architrave and frieze are usually equal in height, it results from 3d and 4th requirements that height of the entablature, omitting the geison, is one-third height of the column. The rude temple at Selinus but partially fulfils these requirements. (According to Pliny, the height of the column was at first one-third the width of the temple). The following monuments retain these numerical ratios. Temple A at Selinus; Temple of Poseidon at Paestum; Temple of Zeus at Olympia; Temple of Athene on Egina.

These numerical ratios recommended themselves for practical reasons; the made the designing and execution easier, and were perhaps prescribed by the priests. They could not form a rule for all cases and all periods.

When architecture assumed a bolder flight and freed itself from ancient priestly restrictions, men first abandoned the limit of height of the columns and made this greater, so that the column without its abacus, or its shaft alone, attained a height h = 2a. The architrave block firmly retained till later the ratio of 1 to 3. The entablature thereby became lower in proportion to the column. But the other law remained in force, that the parts of the building should be similar to each other and to the whole. This harmony comprises 1, the similar forms of the two principal parts, the enclosure and the nucleus, or the peristyle and the cell; 2, the repitition of the same forms and proportions in the parts of the build-

ing.

46. Ground Plan.

1. With all diversities in length and breadth, comparison of the plans shows an intention to give the outer line of the peristyle (edge of upper step) the same form as that of the interior of the cell. (Figs. 3,15). Porticos are very deep before and behind the cell, but are very narrow along its sides, an arrangement not explained on structural or practical grounds. If the diagonal of the rectangle of edge of upper step be drawn, it either coincides with the diagonal of interior of the cell, or is parallel to it. With few exceptions, this is true for the plans of all Doric temples, even for the little archaictemple-cell on the Acropolis at Selinus.

47. ~~Entablatures.~~ Facades of Cell and of Temple.

2. The facade of the cell, so far as visible, or to bottom of inner architrave, and the facade of the entire temple with its stylobate, form two similar rectangles (with the ratio of 2 to 3 in the archaic style); the cell and its peristyle have similar forms. (Fig. 4). To produce this conformity, high entablatures and stylobates are necessary in case of temples with a wide space between colonnade and cell, lower entablatures being required for temples with narrow porticos. (Figs. 6,7,8). This also explains why external entablatures are frequently lower(Fig. 9) paestum, or often higher (Fig. 10) Bassae than the internal one. In other words, the peristyle adds to the cell proportionately as much in height as in breadth.

48. Entablatures.

3. Each pair of trilyphs enclose a metope and form with the portiom of cornice above them a combination, in several ways exhibiting a similarity to the entire building, viewed from front. As the cell-walls and columns along the sides inclose a darkened vestibule (pronaos), so do triplyphs in the frieze inclose the metopes. These appear like small spaces beneath the protection of the widely projectijg roof, and they are open in front and filled with sculpture, like the pronaos of the cell. A closer observation shows that the two likewise coincide in the ratios of their magnitudes. The form of the metope varies similarly from a square, as does the opening of the pronaos. (Figs. 9,10). The width of the triglyph also bears the same ratio to width of metope, as that of width of portico, including columns and walls to width of pronaos (measured between antae). Simple numerical ratios are most common:

Temple C at Selinus, 1 to 1.

Temple of Poseidon at Paestum, 3 to 4.

Temple of Concordia at Agrigentum, 2 to 3.

Temple of Athene on Egina, 3 to 5.

Temple of Apollo at Bassae, 3 to 5.

Narrow cells therefore require narrow metopes, and wide porticos demand broad triglyphs.

The band at the top of the metopes is also analgous to the internal architrave, while the projecting mutules correspoud to the ceiling of the vestibule. A comparison shows that the mutules, taken with the two bands beneath them, actually have the same ratio to the metope, as the entablature to the cell. (Figs. 9,10). These portions of the entablature and the taenia with its regula were always marked by their deep color as belouging together. They repeated the form of the entire building on a small scale.

Further, the geison is to the triglyph-frieze just as the entire entablature is to the cell-walls and to the columns. Indeed, the height of projecting cornice almost invariably has the same proportion to height of the frieze (including mutules with frieze), as height of the entablature has to height of the column. Compare corresponding profiles from Paestum, Egina, and the Parthenon. (Figs. 11, 12,13). Thus the principal ratios between stylobate, column, and entablature, are repeated in the larger and smaller subdivisions of the entablature.

But a relation between the smaller and larger parts is carried out in the projections, with especial reference to outline. The portion of the abacus projecting beyond the shaft of the column likewise forms a rectangular projection similar to that of the geison, taking a diagonal view of angle column. The profiles of capitals represented in Figs. 11 and 12 are to be considered as diagonal sections projected on the facade of the temple. The entire entablature, so far as it projects sidewise beyond the body of the cell, and the geison, as well as the drip-mouldigg, form projecting and similar figures. (Figs. 11,12). The extended diagonals of the facade of the cell usually pass through the angles of these figures, thereby fixing the ratio of their breadth and height.

49. Elevation of Entablature.

4. On the elevation of the entablature exist the following harmonies between horizontal figures. The two architrave-blocks abutting over a a column form a surface 6 times longer than high, according to an archaic rule. (Fig. 14). A similar rectangle always appears in the abacus of the capital supporting these blocks; a similar figure is also formed by the entire entablature of the facade, and it appears again in the graceful regula and guttae, which are a reduced representation of the entablature of the facade, with its six conical supports.

The form of the cornice block, if its height be one-half the height of the architrave, which is true as a rule, is the same (1 to 6), and also as the form of the triglyph-cap. Thus on the facade of the Doric Temple, this relation is carried out in the most minute detail and is intimately connected with the number six of the columns (on facade).

50. The Parthenon.

Only an architect of genius like Iktinus dared permit himself to depart from traditional arrangement, when he assigned eight columns to the facade of the Parthenon. He thereby abandoned the harmony of cell and metope, as well as that of architrave-block and entire entablature, but thus obtained perfect harmony between the interior and the exterior of the temple, that had never occurred in the hexastyle plan. The plan (Fig. 15) shows how the inner area of cell included between columns, harmonizes with entire interior enclosed by walls, just as this is again similar to external outline of the cell, and lastly to the outer colonnade. It was thus possible to obtain harmony between cell and peristyle in all parts of the edifice. (Fig. 16). It occurrs here, both with and without stylobate, in the last case taking architrave of the inner colonnade together with height of the cell. The facades of cell and of entire structure here form rectangles of 1 to 2 instead of 2 to 3.

Of other relations, the following are retained: ratio of height and projection of cornice to height of frieze, as well as of height and projection of entire entablature (beyond side walls of cell) to height of columns. (Fig. 12). This figure gives projection of drip-moulding, and that of abacus of capital viewed diagonally.

On the entablature of the Propyleum, otherwise very similar to the Parthenon, the geison projects considerably more, corresponding to the great depth of the portico.

51. Later Buildings.

The architect of the Parthenon followed the hexastyle arrangement in the construction of the Temple of Apollo ax Bassae, but the expression of boldness was varied still more than the case heretofore in buildings in Attica. The character of the edifice is determined by form and proportion of the column. This is the only living element in the stiff construction of the structure. The diameter and diminution of the shaft, the profile and projection of the echinus again vary in each temple, according to the taste of the architect and the prevailing acceptations of the period. In the archaic temple, the strongly diminished shaft and fleshy, widely projecting echinus express a high degree of energy, that the column exerts against the load of the entablature. When the columns later

became higher and the entablature was proportionally lower and lighter, men were satisfied with moderate display of force by a stumpy and lean form of capital. The skeleton of the structure remained almost exactly the same, but meagreness and weakness took the place of muscular strength and energy.

An intimate relation likewise existed between diameter of column and certain dimensions of the building. The width of the triglyph was always either half the lower or middle diameter of the column. Since two spaces between trigylphs are found over one intercolumniation, widths of the triglyphs must be in proportion to metopes as are diameters of columns to their intervals. The compressed arrangement of the columns, or their closer setting, is repeated in the arrangement of triglyphs.

It further results from relation of width of triglyph to width of portico, as stated in Art. 3, that in the older buildings these also depend on diameters of columns.

Table of Ratios.

		Diam. of Column to Interval.	Triglyph to Metope.	Width of Portico to width of Pronaos.
Temple of Poseidon at Paestum	(Mid.Diam.)	3 to 4	3 to 4	3 to 4
Temple of Hercules at Akragas	(Mid.diam.)	3 to 4	3 to 4	3 to 4
Temple of Athene on Egina . .	(Low.diam)	3 to 5	3 to 5	3 to 5
Temple of Athene at Syracuse.	(Mid.diam.)	2 to 3	2 to 3	2 to 3
Temple of Theseus at Athens .	(Low. diam)	2 to 3	2 to 3	2 to 3
The Parthenon at Athens	(Mid.diam.)	2 to 3	2 to 3	2 to 3
Temple of Apollo at Bassae. . .	(Mid.diam.)	3 to 5	3 to 5	3 to 5

52. Other Proportions.

It would be faulty to treat colonnades only from the point of view heretofore assumed, and to not also take into consideration the ratio between masses of the supporting and supported parts. It is always the conquest of loads or victory over masses, which impresses us in looking at monumental buildings, and in Doric temple architecture, this is especially the clearly expressed capacity of supports to resist the weight of load laid upon them.

The ratio between the mass of a column and the mass of the portion of the entablature resting on it may be most easily observed, if the areas be considered, which these members of the structure occupy on the elevation. The portion of entablature between axes of two columns is of the same size as the part of entablature supported by a single column. Draw

diagonal of rectangle formed by axes of two columns (Fig. 17) and extend it to top of entablature, where it will cut off a distance d; construct- ing a rectangle with this and height of column, the surface d h is form- ed, whose area equals area a × h of the given portion of entablature. A test of the different colonnades of Doric temples by this method shows, that in archaic monuments entablature area exceeds column area, and that in the developed style, areas of the two parts approximate equality. In the Parthenon (Fig. 18) and in the Temple at Bassae, entablature area e- quals that of a prismatic support, constructed with the upper diameter of column as a base d.

Equality of volume occurs between a prism with a square base and a cy- linder of equal height, if side of the prism is .886, or approximately .9 diameterof cylinder. Assuming as at the Parthenon, that upper diameter of the column is .8 of lower one, then may the cylinder constructed with average diameter of .9 be assumed to equal the conical column in volume, and from this it results that side of a square pier of equal volume is .886 x .9 = .797, or .8 lower diameter of column, so that the mass of a square prism constructed with upper diameter of column equals mass of col- umn. This equality is likewise found in less closely set colonnades of porticos of the era of Alexander, as in inner portico of southwest build- ing at Olympia. (Fig. 19).

In conclusion, it may be added that of all ratios, that of equality (1 to 1) has shown itself as most important. This is found between two successive parts occurring in intimate connection, as between echinus and abacus of capital, the architrave and frieze, and also in most temples, between diameter of column and height of architrave. Otherwise, in parts treated as diversely as possible, equality as a ratio is a condition of good ~~form~~ compatibility, and conversely.

53. Proportions in Egyptian Architecture.

Similarity of figures, was then recognized and required as a condition of good form in architecture in the construction of Doric temples. It is not conceivable that this rule was unconsciously retained by instinct and by thoughtless repetition. It appears to have been transmitted as a secret of the craft in workshops and mechanic guilds of the Greeks. Its first establishment is lost in the darkness of the prehistoric period. We have reason to suppose that since a rule existed for Grecian sculptors, a similar one must have been in use even earlier in architecture, even in Egypt during the famous 18th dynasty.

We shall not be criticised for this review of the land of the Pharaohs. Hellenic purists are dissapearing, who hold Grecian art as a purely nat-

ive growth of Greece and absolutely reject the assumption of an oriental or Egyptian influence. The horizon of the history of art is enlarged. The works of F. Thiersch, Roth, and of Braun, have not been in vain. The important point is that we may assume as proved and accepted the connection of the Doric style with Egyptian architecture.

The style of the gigantic edifices at Thebes was developed further in another direction, when the cell was surrounded by a system of chambers; but several monuments of the beginning of that great epoch exhibit the simple plan of peripteral temple, later abandoned or set aside. The most carefully studied temple of this kind was built be Amenophis III on the island of Elephantine, and exhibits in a very striking way the prototype of the Doric temple. (Fig.20) The cell is similar to the enclosing peristyle in both plan and elevation; its facade, so far as visible, likewise forms a rectangle with ratio of 2 to 3; its base corresponds to the sub-structure of the whole.

We likewise observe in buildings of the same era the ratio of height of architrave to its length (1 to 3), so firmly retained in Doric temple architecture, evidently a rule tested in stone construction at an early date. The use of diagonals of a rectangular figure for determining breadth and height of the members enclosing it appears to have already been common. The cavetto cornices of portals and niches are always arranged accordingly.

Finally, the plan of temple prevailing in Egypt, with its repeated enclosures, exhibits more less clearly the general principle of repitition of primary figure. This is here given by the cell in connection with a transverse portico. (Edfou, Danderah, Erment, etc.) This subdivision is indeed first and most clearly apparent in the temple structures of the Ptolemaic period. We shall therefore not go too far in saying, that as Pythagoras of Samos brought mathematics of Egyptian sages to Greeks. so in remote antiquity, architects, now unknown, transplanted the type of temple architecture and principle of similarity from the land of the Nile to the shores of Greece.

Chapter II. Proportions in Ionic Architecture.

54. Ionic Temples in Attica.

We will consider Ionic temples in Attica, then those in Asia Minor, finally examining works by Roman architects. The temple of Nike Apteros at Athens and the destroyed temple on Ilissus have colonnades only at ends of the cell; the portico and cell coincide in front view. Equal height and width were required, and as in the cell of the Doric temple, while the ratios of side and front differ. But the same similarity of cell and

portico exists in both side view and facade of the Doric temple. To obtain similarity of the inner and outer forms, high entablature and stylobate were required for the short cell of the Temple of Nike. (Figs. 21, 22). The lowness of these parts in the Temple on Ilissus is required by the oblong form of cell. (Fig. 23). Both rectangles have a ratio of 1 to 2.

The Erectheum is a remarkable example of an unsymmetrical though harmoniously arranged structure, but it obeys the law of agreement in another way. The two porticos added at sides of the principal structure have in plan the same shape as it (ratio 2 to 3), (Fig. 24), are entirely different in dimensions, level, and design, but are similar to each other in outline (width: heigh), if the parapet wall o, which the caryatids stand be taken with them as height of supports. (Fig. 27)

The entablature of this Attic-Ionic temple is in composition analagous to the Doric entablature. The architrave and frieze are equal in height, but are otherwise as different as possible. The architrave is plain or composed of horizontal bands; the frieze and its relief sculptures form a series of vertical figures. Upon it rests the cornice, just as the entablature lies on the columns, and the ratio of the height of geison to that of frieze is the same as that of height of entablature to height of columns. The heavy ratio of 1 to 3.5 is repeated on the Temple of Nike, (Fig. 25), and the lighter one of 1 to 4.2 is found on the Erectheum (Fig. 26). The projection of geison is also in proportion to projection of entablature in front of cell wall. Taking the cornice as including cymatium and roofing slab, it is again the same ratio to entire entablature, as this is to height of columns. The same proportions are repeated on a larger scale in the design of the caryatid portico; the statues bear the same proportion to substructure and to their entablature, as that of the sculptured frieze to architrave and to crowning above it.

55. IOnic Temples in Asia Minor.

Varying from the preceding, the Ionic entablature in Asia Minor is composed of four courses, successively diminishing upwards. This is shown by the temple at Priene, (Fig. 28) the Temple at Magnesia, and the Mausoleum at Halikarnassus. The ratio of architrave to frieze is the same as that of frieze to dentil band, and that of dentil band to cornice. Each member of the series has the same proportion to the succeeding one, and the ratio of any division of the entablature to the entire portion above it is likewise always constant (a geometrical series). An attempt is made in Fig. 28 to construct a scale for gradual dimunitions of the divisions. The height of frieze is actually greater than given by this method; but

a portion of the frieze is always concealed from the eye by the architrave moulding, so that the frieze therefore appears lower than it really is. It should further be noticed that the cymatium or crowning member of a division of the entablature is always in a fixed ratio to it. This is also true of the Ionic entablature found at Olympia. The same regular diminution of courses of stone and of their crowning mouldings appears on the entablature on the interior, where it is terminated by the coffers.

The plans of temples in Asia Mijor either resemble the Doric peripteral temple (Priene), retaining harmony of cell and of peristyle on the ground plan, or a second complete peristyle is employed, producing a dipteral temple. (Ephesus, Miletus). According to Vituvius, Hermogenes invented the pseudipteral temple by omitting the inner colonnade. The necessity for treating the cell and peristyle conformably then became greater, on account of the greater lightness of the portico, than in the dipteral temple. Correspondence in plan was more easily obtained than in outline, and that was only produced by cutting off a part of the cell wall by a string-course, or by separating a substructure or base from the cell. (Fig. 29.) This is shown by later Temples of Aizani, Aphrodisias, and Baalbec. In the Temple of Artemis at Ephesus, the cell appears to have had a high base decorated by sculptures and of the same height as the sculptured portion of the shafts of the columns.

56. Grecian Secular Buildijgs.

A few Greek secular edifices exhibit the same principle of harmony. On the front elevation of the Tower of Winds at Athens, the inner and outer outlines of porticos are similar to each other. (Fig. 39). The two rectangles are concentrically arranged, and the general form of the tower is arranged about the same centre. As the entablature is to the columns, so is the crowning cornice of tower, with sculptured frieze beneath it, to the tower. Entablatures of the porticos are composed of constantly diminishing parts, as in Asia Minor (Fig. 31); but they correspond in outline to the Corinthian capitals beneath them, if these are viewed diagonally. The angle of the entablature is indeed most apparent; the diagonal profile of the capital lies in the same plane with it. These two profiles harmonize in all essential points.

As the abacus of the capital is to the bell, so is the cornice to the entablature. The projection and height of these parts bear the same ratio to the parts beneath them in both figures; the outline enclosing the acanthus foliage is similar to the projecting moulding of the architrave. The same similarity of profiles of capitals and entablature is shown by the monument of Lysicrates, but on account of the circular plan, it is

not the diagonal but the normal profile that corresponds in outline. (Fig.32)
The same is also found in the Doric style. On the monument of Thrasyllus at Athens (Fig.33) and on the Temple of Artemis at Eleusis, profiles of antae-capitals harmonize generally with those of entablature. The projecting portion of abacus corresponds to projection of geison; the height of hawksbill moulding of antae-capitals with its fillets is in proportion to frieze of entablature, and the flat band to the architrave. The palmetto-band on the necking of Ionic antae and on the cell wall is analogous to the sculptured frieze of the entablature.

57. Ratio of Masses.

Finally, the ratio of masses of supports to those of loads is to be considered. In Doric colonnades as a rule, the mass of entablature exceeded the mass of column. In Attic-Ionic monuments, the columns were further loaded by a pediment, and mass of the column was therefore greater than mass of the entablature. In the Ionic porticos of Asia Minor , entablature is universally lighter than column. The lightest load rests upon the Corinthian capital. The ratio of masses is to be further considered in the case of complex buildings in stories. The upper story may be higher than the lower one, if its mass be smaller (Monument of Lysicrates, Tomb at Mylassa). The same ratio prevails here as that between mass of a statueand that of its pedestal; the latter must be the greater of the two.

Chapter III. Proportions in Roman Architecture.

58. Italian Temples.

New forms appear in Roman temple architecture, but in spite of all transformations, ancient principles still prevail. The Italian temple has a portico before the cell only and stands on a high substructure, only ascended in front. Yet the same harmony is produced here as in the Attic-Ionic temples. For the cell and the entire edifice form similar figures in side view (Fig. 34). Most rectangles also have here simple numerical proportions, which are repeated. The substructure and the entablature add as much in proportion to the height of the cell, as the projecting portico adds to its length.

The sides have the following numerical ratios (height to length):

Temple of Fortuna Virilis at Rome - - - - - - - - - - - - - - -2 to 3
Temple of Jupiter at Pompeii- - - - - - - - - - - - - - - - - - -1 to 2
Temple of Antoninus and Faustina at Rome- - - - - - - - - - - -1 to 2

harmony is more perfect in circular temples than in any other form. The visible cylinder of the cell is similar to the entire structure. (Temple of Vesta at Tivoli). If the columns stand on steps only, the cell

must have a string-course in order to not seem too high. (Temple of Vesta, Rome). We meet everywhere with similarity of internal and external forms in the varied ground plans of the temples of the imperial period. When the cell is enclosed along both sides by porticoes, facades of cell and of entire building are similar to each other (Temple of Mars Ultor and Temple of Dioscuri on Roman Forum). A string-course separates the cell from the base, which is then analagous to the substructure beneath columns. The similarity of the cell to peristyle is carried farthest on the Temple of Jupiter at Baalbec. (Fig. 35).

In abnormal plans of temples, like that of Concordia at Rome, (Fig. 36) where the portico before the cell is narrower than that, the two still have similar forms. The portico of the Pantheon harmonizes with the circular edifice, since the two have the same ratio of width to height, although otherwise so vegy different. The pediment is itself too much inclined, but harmonizes with the dome covering the cylindrical portion. The interior of the Pantheon everywhere affords examples of beautiful harmony, possessing almost Grecian purity. The equality of height and width of the entire interior is repeated in the openings of the great niches. The pilasters of the upper order are grouped just like the columns and pilasters of the lower; the upper arrangement being repetition of the lower at half size. Finally, the columnar enclosures of the small altars harmonize with the two great pilasters which flank the mass of the pier and form on the sides of the small niches a concentric symmetrical bordering. (Fig. 37).

59. Triumphal Arches.

Triumphal arches merit special notice by their original and harmonious composition. The rule is adhered to, that the two columns or pilasters enclosing the archway must form a figure similar to that of the archway itself. The inner pair of supports carry an arch and the outer pair a horizontal entablature, this contrast being harmonized by the coincident ratios of width to height. (Fig. 38).

On the Triumphal Arch of Titus, (Fig. 39) the square is used as the basal figure and is generally retained, though the attic is rather too high, a defect avoided in the Arch of Trajam at Beneventum. On the Triumphal Arch of Trajam at Ancona, (Fig. 40) a rectangle with greater height than width and a ratio of 1 to 2 for its sides is employed for the opening, for the inner and outer lines of the adjacent engaged columns, as well as for the entire outline. The columnar order of the portal is further enclosed by the mass of the structure with proportionally similar width and height. At Hadrian's Gate in Athens, (Fig. 41) three pairs of sup-

ports with similar intervals enclose the passage way, the upper story repeating the same form.

The Triumphal Arches of Septimus Serverus and of Constantine (Fig. 42) with triple openings, exhibit the same relation between the archways and their enclosing members. For practical reasons, the side openings for persons on foot are narrower than the principal gateway, intended for riding or driving. The returned portions of the broken entablature must here be taken with the columns, when these are compared with the piers of the archway. The impost cap is even analogous in composition to the cornice. But if the two columns at the sides of the principal archway be taken alone, they enclose a square central area (height of columns being equal to distance between them), and the mass of the entire structure encloses this at the sides and top by an equal width. If the gateway be further assumed as filled by a crowd of men (6 feet high), it also becomes square and harmonizes with the adjacent columns, as in case of the other monuments. The side archways then approximate the form of the principal gateway.

Moreover, the height of attic of Arch of Constantine is so arranged as to make the middle archway relatively as high as the side archways; (Fig. 43). or the facade forms a group of three similar parts standing beside each other. As the horizontal entablature extends above the principal gateway, and the space for inscription covers the attic, so are bands of reliefs and sculptured panels placed above the side archways. Harmony in proportions of masses, but variety in treatment of analogous parts, are leading principles in Roman composition. Simple numerical ratios always participate here. The distances between the axes of columns are in proportion as 2 : 3 : 2. The principal gateway forms a rectangle whose sides are as 3 to 4; height of columns is twice the height of pedestal, etc.

60. Proportions of Elevation.

The relation between the parts of elevation successively above each other must still be shown. This most plainly appears in the side view of the triumphal arch. (Fig. 44). The subdivision of principal story into pedestal, column, and entablature is also repeated in the attic. The ratios of these parts of the elevation to each other are as 2 : 4 : 1. The pedestals of columns and of statues are subdivided in a strictly similar manner. The same analogy appears in the elevation of the Incantada at Salonica. (Fig. 45). The repitition of the design of the entire structure in its subdivisions is very clearly shown in the outline of the Temple of Fortuna Virilis (Fig. 46). The cap of substructure is a repitition of the entablature, and the base of substructure repeats the substruct-

ure itself, the profile of the base corresponding to the base of the column taken with the steps. The similarity of subdivision of the pedestal and that of the entire order is most accurate on the Arch of Septimus Severus. Compare also the shrines of the Pantheon with the minute subdivision of their bases.

81. Subdivision of Entablature.

Repitition of the general in its parts also prevails in the subdivision of the entablature. While in Grecian architecture the entablature extends upward in an arrangement corresponding to the combination of ceiling and of roof, subdivision of the Roman entablature becomes a purely external decoration. The cornice with its ornamentation here forms the chief part of the entablature and predominates over the remainder. The mouldings crowning the architrave are reduced and simplified imitations or precursors of the cornice. This harmony already occurs in the profile of the Grecian entablature; it is also very distinctly shown in profiles of Italian entablatures, and it governs the subdivision of richly sculptured marble entablatures of the Roman imperial period. In the Grecian entablatures, the upper fascia of the architrave with its mouldings and the crowning fillet is a model of the entire entablature. (See Erectheum Temple of Nike, Temple of Priene, and Tower of Winds; Figs. 23,25,28). The subdivision of the Italian entablature is such (Fig.47), that the upper fascia of architrave bears the same proportion to the mouldings crowning it, as that of frieze to cornice. (Caps over doorways at Cori and Tivoli and entablatures at Pompeii).

Both modes of subdivision have been applied to Roman profiles. The Grecian principle is followed in entablatures of Temple of the Sun by Aurelian (Fig.49), with its architrave divided in two fasciae, and of Temple of Antoninus and Faustina (Fig. 48), as well as in those of Temples of Dioscuri and of Concordia on the Roman Forum, divided in three fascias.

The Italian proportion is employed in almost all other examples now remaining; as the cornice is to the frieze, so is the crowning moulding of the architrave to upper fascia (Fig.50). The three principal divisions of the entablature, cornice, frieze, and architrave, are usually of equal height (omitting cyma of cornice), and correspondingly the crowning moulding of architrave, the upper fascia, and the middle fascia with its moulding, all form equal parts. The same contrast of moulded and plain members placed side by side and equal in height is repeated in the lower division of the cornice.

Moreover, the cornice usually bears the same proportion to the height of its lower portion as the fillet of the architrave to its moulding. (

Orders of Coliseum, of Portico of Octavia, of Shrine of the Pantheon, and of Temples of Dioscuri and of Concordia). Where the crowning moulding of the architrave has a cavetto according to custom in Asia Minor (Temple of the Sun by Aurelian (Fig.49) and Temple at Palmyra (Fig.51), the cyma must always be taken with the projecting cornice in the comparison. Yet this also occurred in the Pantheon, on Temple of Vespasian, and on Forum of Trajan. Where offsets of the architrave are decorated by ogee mouldings ornamented by leaves, those exhibit a regular increase in height towards the architrave cap moulding. An example of this and of the repitition of main divisions of the entablature in subdivisions of the architrave is the beautiful cornice from interior of the Pantheon above the entrance doorway (Fig. 52).

A more important relation also exists between the profile of the capital of column and that of entablature. As on the Tower of Winds at Athens (Fig. 31), the two profiles correspond in projection when viewed diagonally, as well as in subdivisions in height. The geison, either with or without the cyma, corresponds to the abacus, and the three divisions of the entablature to the three rows of leaves on the bell. The modillions that support the geison are analgous to the volutes which curve beneath the abacus. (Fig.53) From this point of view, the Composite capital is completely justified. The minute subdivision of the cornice is especially prefigured by the bold and ornate division of the surface of the bell. The same relations are found in the plainer treatment of Roman, Doric and Tuscan orders, between profiles of the capitals of columns or pilasters and the entablature. (Fig.54). Compare with this the Grecian example (Fig. 33).

While the Grecian style thus places large and simple forms beside each other, apparently without adjustment, but holds them in stricter dependence upon the entire structure, Roman architecture, after this conneetion is loosened, is pleased by repeatedly subdividing the parts of the entablature into forms similar to itself. The gracefulness thereby obtained affords compensation for omitted sculptured ornamentation of the Grecian entablature. (Compare profile from substructure of Temple of Mars Ultor, Fig. 55, with that of Doric capital from Theatre of Marcellus, Fig. 56).

62. Statements of Vitruvius.

As Grecian and Roman architects were guided by this primary principle, the question arises whether it has nowhere been stated? Such an important point of theory could not be kept secret and could not be assumed as self-evident. We must seek whether the basal principle was stated anywhere in the writings of the ancients. The writings of Grecian architects

and the commentaries on their temples are indeed lost, but the work by the Roman architect Vitruvius, dedicated to Octavianus, is preserved, and since this was drawn from Grecian sources, information in regard to our problem may be expected from it. He indeed spoke of this in three places, although not with all detail and clearness that might be desired, yet so plainly as to permit us to percieve that similarity of form was a transmitted law of architecture.

First, where Vitruvius speaks of the rules of Architecture in general (Book I, Chap.2), and he speaks of the construction of temples in particular (Book II, Chap.1), he requires "symmetry" to be observed. He does not mean by this the equality of two halves, making one side a duplicate of the other; no special law being needed for this. His explanation is different, and this rather arbitrary law runs thus in Gwilt's translation = " Proportion is that agreeable harmony between the several parts of a building, which is the result of a just and regular agreement of them with each other; of the height to the width, this to the length, and each of these to the whole." Thus the parts must harmonize with each other and with the whole; they must correspond to each other and to the form of the whole. By this harmony and correspondence is undoubtedly to be understood similarity of forms of the parts and of the whole.

Take the opinion of Euclid, the ancient master of geometry, Where he treats of the similarity of figures in Book VI of his Elements, he employs the word "analogous" in definitions and theorems. Thus in Theorem 4= " If triangles have equal angles, the sides opposite equal angles are analogous to each other". Cicero also rendered the word "analogia" by "proportio" in his translation of the Timaeus. Return to Vitruvius, who says (Book III, Chap.1): "The design of temples depends on symmetry, whose rules architects should be most careful to observe. Symmetry is dependent on proportion, which the Greeks call "analogia". Proportion is a close adjustment of the sizes of the different parts to each other and to the whole, as on this proper adjustment symmetry depends."

The explanation which Vitruvius gives after the definition quoted is indeed different from what might be expected, being that as in the human bofly, so in an architectural structure, should all parts form a definite repitition of a unit of measure. To express this, did not require that detailed definition of symmetry. Did Vitruvius possibly reproduce the Greek definition without fully understanding it? He ends the chapter with the words (omitted by Gwilt, but translated from Reber's Vitruvius): " We admire those, who, when they built the temples of the immortal gods, so arranged the parts of their works that taken separately or as a whole,

their subdivisions have been treated in accordance with proportion and symmetry".

Chapter IV. Proportions in Early-Christian and Mediaeval Architecture.

63. Early Christian Basilicas.

Let us trace these ground principles further in the History of Architecture. Paganism was overthrown, temples of the Gods fell into ruin and new ones were built no longer. Religious traditions of paganism were broken and extinguished by the victory of Christianity, which likewise caused architectural traditions to pass into oblivion. Instead of antique temples, Christian basilicas were erected, and church architecture was steadily developed in buildings at Ravenna, in domed structures in the Byzantine Empire, and in the Romanesque and Gothic architecture of the West. If the theory of proportion be not based on caprice, but on the nature of the case, and of the spirit of the man, on the laws of the beautiful, then will it appear in these new domaijs also.

No value was placed on the exterior of the basilica, so that we can expect no systematic treatment there. Chief emphasis rests on form and treatment of the interior. The rule is general, that side aisles must have the same ratio of height to width as the centre aisle. (St. Apolliuare-in-Classe at Ravenna; Cathedral of Parenzo, Fig. 57). The most important internal effect of the basilicas depends on the long rows of columns. These exhibit in perspective a series of contiuually diminishing similar figures with regularly lessened widths. On this fact is chiefly based the beauty of the uniform rows of columns.

64. Early Christian Centralized Buildiugs.

The treatment of centralized structures is of a different nature. Already in Roman architecture were the abutments of the dome transformed into a circle of niches. These are now treated simarly to the principal space. It is found in St. Vitale at Ravenna (Fig.58) that the columns of the niches enclose figures similar to those enclosed by the great peirs of the octagon of the dome. The same is true in the apses beneath the great semi-domes of the Church of St. Sophia at Constantinople. The number of columns in the second story is increased so as to retain the same proportion of height of column to intercolumniation. For there are seven intervals in the upper story to five in the lower, while the heights of the stories are as five to seven. It is scarcely necessary to refer to the usual plan of the Byzantine church, where the main dome is accompanied by several similar side domes.

65. Romanesque Churches.

The harmony in Romanesque churches between center and side aisles, and principal and side apses is merely approximate. The round-arched frieze and the low-arched gallery are repetitions of the arch beneath them., like the triglyph-frieze above the colonnade. Proportions of the stories are frequently fixed by the treatment of the openings. Thus, where two arched openings are placed above each arch of an arcade, the upper columns have one-half the height of the lower ones. (Cathedral at Pisa; Cathedral at Autun; Church of St. Saturnin at Toulouse, Fig. 59). The similarity of side aisles to center aisle is frequently expressed in the facade. In St. Zeno at Verona, the portal also repeats the same form.

66 Gothic Churches.

We now enter the domain of the Gothic style. It differs extremely from the classic styles and completely breaks from antique traditions. It partly adheres to the older church architecture, but otherwise develops a very peculiar nature. This is that all large forms are repeated in details or imitated in smaller parts. Pinnacles, gablets and blind tracery are repetitions of towers, gables and window tracery. The manner in which these elements spring from the mass of the building corresponds to tree growth, whose branching and ramifications, even its most delicate twigs, continually repeat a fixed form. Where this does not overload the masses of the building, examples of simple and clear treatment are to be found. Thus on the Church of St. Elizabeth at Marburg. (Fig. 60).

The simple numerical ratios of principal dimensions are first emphasized: height and width of three-aisled interior equal each other; width of middle aisle from center to center of piers is twice the width of side aisles. The plain facade with two towers is effective by its proportions, by the fine appearance of the masses, and invites study of the proportions.

Center lines of buttresses divide width of the facade in proportion of 2 : 3 : 2. The chief lines dividing the height are accented by foiled bands, which show that height of the tower to base of spire (bell story) is twice the height of nave. The shaft of the tower from cornice of nave to bell story has the ratios of 4 : 2 : 5 to this and to the spire. To this larger form correspond the small towers at angles of bell story. The opening of the doorway, the wall area containing the portal, and the crntral area of the facade above this, are figures similar to that of the facade of the church below bell story.

Above the central area of the facade, whose large and rich tracery window forms the principal figure, the applied tracery with gabels and fin-

ials is arranged like the spires with their gables and pinnacles above the facade. The high wall spaces of the towers with their slender windows are enclosed by masses at sides and below, in proportion to the two windows of the facade beneath them. Especially effective is the visible reduction of masses by offsets with increased heights of the stories. The higher the stories of the buttresses, the more is their width diminished, so that approximate equality of masses results in two successive portions of the piers.

The most beautiful window tracery is composed of larger and smaller mullions, which repeat the larger, as the separate parts do the whole. With harmony in principal ideas, the greatest diversity in other parts is required to avoid monotony and produce a pleasing contrast. The capitals of the little shafts of a Gothic pier are frequently decorated by leaves whose mid-ribs or stems bend over, spring from and intersect each other, just like the ribs of vaults above them; this is here given on a small scale, but is to appear on a large one.

We limit ourselves to noting that the facades with two towers for the finest cathedrals are subdivided to produce similar rectangles, that the central space with rose window is usually similar to the entire facade, and that heights of stories of towers either continually increase upwards, producing an aspiring tendency, or diminish as the stories become narrower, like minarets in Cairo, whose beauty consists in similar proportions of stories, and in the diversity of their ornamentation. The examples show that Gothic made the most extensive and frequent use of the principle of repetition of main forms in details.

Chapter V. Proportions in Renaissance and Modern Architecture.

67. Churches in Italian Renaissance.

The Middle Ages drew to an end; chivalry and romantic poetry disappeared; the great Gothic cathedrals remained unfinished. One of the greatest changes in taste commenced. Other ideals were sought and attention was directed to classical antiquity, slightly known and but little esteemed. Admiration of this produced the architecture of the Renaissance. With the architecture of the Greeks and Romans, the ground principle of architectural proportions was again revived and applied. Whether architects first employed this in practice and afterwards in theory, or conversely, or whether it was done with clear understanding or not, the former may be true, for it certainly appears in the most beautiful monuments of the Italian Renaissance. The same elegant proportions appear as in antiquity, while harmony is no longer produced by approximation, but is geometrically exact; in its rich development, Renaissance architecture affords even

more abundant examples and proofs than do the remains of antiquity. Examples present themselves at every step taken under a guide like Buhlmann.

In church architecture, Brunelleschi introduced the same ratio of breadth to height for middle and side aisles (St. Lorenzo and St. Spirito at Florence); Baccio Pintelli exhibits these harmonies on facades of churches at Rome (Fig. 81), extending to their towers. In churches with a single aisle, for which Alberti gave a model in St. Andrea at Mantua, apses between abutments of the dome repeat the form of transverse aisle, and are in the same proportion to this, as are the smaller niches to the apses. Still more decidedly in the Church of St. Maria di Monti in Rome do the chapel openings in the piers imitate the main interior.

The subdivision of the Roman triumphal arch (outline of side division being similar to that of middle portion) reappears on the monumental tomb of Dodge Vendramini at Venice, as well as on Tombs of Prelates in St. Maria del Popolo at Rome. Subordination of lesser to principal arches occurs most simply in the cross section of the Church of St. Salvatore in Venice (Fig. 82) and is repeated in the altars and wall tombs of the church.

In centralized churches, smaller domes follow principal dome in plan and elevation (Fig. 83). The drum beneath the dome soon formed an upper story and had externally the same ratio of breadth to height as that of the entire church beneath it. Examples are St. Pietro in Montorio at Rome (Fig. 84), Consolatione at Todi by Bramante, and Church of St. Peter at Rome as designed by Michael Angelo (Fig. 85). It is a merit of Michael Angelo, that he succeeded in retaining this harmony in erecting the Church of St. Peter, when he attached to the exterior of the church a single great order of pilasters and repeated its ratio to the attic in the arrangement of the columns of the dome. (Compare similarity in outline of upper and lower stories of Roman triumphal arch Fig. 44)

88. Private Buildings in Italian Renaissance.

When we turn to private buildings in varied forms, we find the same law in all their parts, in general and in detail. A part added or prefixed to the principal mass must accord with that in its proportions. The upper story of Pitti Palace at Florence is similar to the entire building (half as long and half as high); projecting porticoes of Villa Rotonda repeat the form of the building, etc. (Fig. 86).

89. Subdivision of Facade.

This rule for subdivision of the facade was first made in Florence; as the string-course is to that story, so is the entablature to the palace. This principle was first applied on the Strozzi Palace (Fig. 87) with great success. The entire height is divided in three nearly equal parts. Each

of the two lower stories terminates with a belt-course, which with the course of ashlar next beneath, occupies one-eight part of the height of the story. Corresponding to this and crowning all three stories, the entablature has three times the height of a belt course, and with its frieze is one-eight of the total height. The same is true of the Piccolomini Palace at Siena. On the Gondi Palace at Florence, the lower story is characterized as a substructure by a bolder rustication, and the entablature is made in proportion to the two upper stories by having twice the height of a belt-course.

This is also the subdivision of most Roman palaces. Y The string-course, that crowns the lower story and marks it a substructure, bears the same proportion to this, as does the entablature to the remainder of the facade (1 to 12 on the Negroni Palace). The simplicity and decision that distinguish Florentine are wanting in these facades. The Farnese Palace is also effective , for it follows the simple division of the Strozzi Palace and ends with an entablature in proportion to the whole as the string-courses and bands are to the separate stories. The entablature has again thrice the ehight of belt-course, if vertical heights are not compared with each other, but actual distances between upper and lower edges are taken, the dimensions that would be least fore-shortened in perspective.

70. Architraves of Doors and Windows.

Rules for architraves of doors and windows exist, and are to be referred to the antique. When a window opening is higher than wide, an enclosing architrave of uniform width is unpleasing. This absurdity is more apparent for wide architraves or narrow openings, than for narrow architraves or openings wider than high. Architraves of openings having greater height than width require an extension above or below, or even both, to make the external and internal outlines similar. For rectangylar openings wider than high, there is oppurtunity to widen the enclosing frame at the sides (Fig. 68). As the cell of the antique temple was surrounded by columns and their entablatures, making the external outline similar to the internal, so is the same true for Renaissance windows and portals. When a simple window architrave rests directly on a string-course, this participates in the treatment of the enclosing member, and there usually exists harmony of inner and outer outlines. (Window of Massini Palace at Rome).

Breadth and height of enclosigg members are usually arranged merely in accordance with diagonals of the opening. This is the case if pilasters or half columns are also added to the architrave of uniform width, as on Bartolini (Fig. 69) and Pandolfini (Fig. 65) Palaces, etc., in accordance

with the shrines in the Pantheon. Peruzzi and Vignola generally employed these diagonals for architraves of doorways, although a base like that of the window was there impracticable. If the breadth of the enclosing member is one third the width of the door, the lintel with its cap is made one-third the clear height of the doorway (Figs. 71, 72) or if the opening of the doorway is twice as high as wide, the height of the lintel is twice the width of the architrave.

71. Wall Openings and Surfaces.

Proportions of wall surfaces enclosing an opening in the wall are of special importance. Proportions are most clearly shown if round-arched window openings are enlarged to rectangular form and diagonals are drawn. Either the diagonals of two adjacent windows intersect below upper limiting line of wall surfaces (Fig. 73), or they intersect the upper margin of the wall space vertically above sides of adjacent openings. (Fig. 74) In the first, the wall surface is so divided by the axes of the piers, that it is a proportionally uniform enclosing member; in the second, the entire mass of wall surrounds the opening with proportionally uniform width.

The first method is used in the Pitti Palace in Florence (Fig. 78) and with more or less accuracy by most Roman palaces with predominating wall surfaces, especially Bartolini and Pandolfini Palaces at Florence (Figs. 69 and 70) The second system is retained in Riccardi, Strozzi, Gondi, and Guadigni palaces. (Figs. 75, 79). If width of the pier equals width of the window, then is the wall above equal to height of windows (upper story of Strozzi Palace). If piers are narrower than openings, as on the Guadini Palace, height of the wall above crown of arches is also in the same proportion lower than windows. In this example, the first harmony is also produced. That the plain wall surface between and above windows must have equal widths is to be referred to the first system of harmony and it is true if height of the windows is twice their width (Pitti, Bartolini and Pandolfini Palaces).

72. Arrangement of Pilasters and Columns.

The same conditions are required in subdivision of facades by orders of pilasters. Pedestal of the pilaster is most intimately related to pedestal of the window beside it. They either form two figures similar to each other, or the pilaster order encloses the window at sides and above in accordance with its diagonals and at proportionally equal distances, thus taking part in the enclosure. Examples of the first are given on Rucellai Palace by Alberti (Fig. 77), lower story of Farnesia (Fig. 76) and Stoppani Palace, as well as Porto Palace in Vicenza; examples of the other kind, by upper story of Garnesia (Fig. 76), court facade of Farnese

Palace (Fig. 80), and principal story of Ossoli Palace, all by Peruzzi. The harmony of the window and the pedestals of pilasters or columns, in geometrical similarity, is carried out by Michael Angelo (Palace of the Senators), by Galeasso Alessi, Sansovine, and Palladio, and the principle is obeyed, that the two supports must be of forms as different as possible. Moulded window jambs are contrasted with plain pilasters, and those with half columns, Hermes figures or rusticated columns. The early Venetian Renaissance also affords beautiful examples (Scuola di S. Marco).

The same proportions also determine the arrangement of pilasters and columns combined with arcades. As on Theater of Marcellus and on Roman triumphal arches, the pair of columns or pilasters should enclose the same figure as the pair of piers (Arcades by Peruzzi and by Palladio, Fig. 81, etc.) To this harmony is due the harmonious effect of Palladio's Basilica at Vicenza, in spite of its ungraceful wide arrangement (Fig. 82); the small columns have here a treatment of their bases with an analogy to pedestals of principal order.

73. Division of Wall Surfaces.

The subdivision of surfaces of walls also requires obedience to the law, that forms of parts must correspojd to that of the whole. This is especially true of that principal portion of the wall surfaces made prominent by size or ornamentation. This is generally found in Pompeian wall paintings; it is continued by the Renaissance and is generally employed in the Rococo style. Examples are shown in the prindipalapartment of the Massimi Palace (Fig. 83), halls of the Palace of Caprarola, and in Assembly Hall of Grand Council in Doge's Palace at Venice. A very common arrangement is to place the door in one wall near an angle, thus taking as much from length of the wall as the wainscoting does from its height.

The same is true for facades, if windows form groups or divisions of different widths. On Palace del Consiglio at Padua, the central group of windows of the upper story is similar to the main portion and to the entire facade, and on Sapienza at Naples, the loggia is similar to the whole. The facade of San Lazzaro in Venice may serve as an example of a design in the Barocco style (Figs. 84, 85).

In panelling the leaves of doors, such forms are preferred as correspond to that of the entire door, and they are surrounded by mouldings that imitate the mouldings of the architrave (Doorway of the Vatican, etc.) This is especially the case in Rococo.

74. Arrangement in Detail.

Subdivision of details likewise obeys the law of analogy. Enclosures of windows with pediments are structurally treated in accordance with the

analogy of the building. Entablatures of the windows correspond to the main entablature, their projection and height being proportioned by it. As many times as the entablature goes into height of facade, just as many does entablature of window go into height of the window order (Fig. 70) Cornice and frieze of Pandolfini Palace go eight times into the total height, and entablatures of the windows repeat all members of the main entablature. and go eight times into height of window order. The corresponding proportions on Bartolini Palace (Fig. 69) are 1 to 8 and 1 to 7. Where the ground story is a substructure, the entablature corresponds to the height of the remainder of the facade. This is approximately true of Roman palaces of several stories. If the height of the window order is one-third height of facade, its entablature is one-third height of the main entablature (Sciarra and Negroni Palaces at Rome). On facades with orders of pilasters or columns, their entablatures control the lintels of the windows, if these do not take the place of the main entablature. (Fig. 76).

75. Profiles and Decorations.

Profiles also exhibit an endeavor to bring smaller parts into harmony with greater. The crowning cornice and the bed mouldings under it, together with the frieze beneath form a group, repeated in the profile of the architrave (in its upper portion or its entirety). Peruzzi and Vignola prefer to follow this mode of subdivision and to arrange the parts of the architrave in a continually diminishing series (Fig. 86). The harmony between profiles of capitals and of entablatures in the antique was again adopted. Height and projection of the bands are proportional to each other, and ornamentation of necking of pilasters is analogous to decorations of frieze. Rosettes on necking of the column correspond to the intermittent ornamentation of the triglyph-frieze, and the foliage of the capital, to a frieze covered by foliage. Beautiful examples are found in the early Venetian Renaissance, the Orders of Alberti, Bramante, etc. The Orders of Vignola and of Palladio are well known in innumerable editions and owe their popularity less to ratios expressed in entire numbers, than to prevailing harmony of different parts with each other.

Annular members beneath the abacus (Fig. 87) have the same proportion to it, as do the frieze and architrave to the cornice. At the offset in the architrave the two fascias harmonize in their equal ratios of depth to width. In Vignola's Doric entablature, the height of geison has to the frieze and architrave beneath it a ratio (1 : 4.5) similar to that of height of architrave to height of column (1 : 4). For Vignola's Ionic entablature (Fig. 88), the abacus of the volutes, the architrave mould-

ing, and the geison of the entablature, are supported by members of ogee section and of relatively equal heights. In Vignola's Corinthian Order the geison covers the rest of the entablature (1 : 6) as the abacus covers the bell of the capital (1 : 6), and approximately as the entablature is to the column (1 : 5). This law extends to subdivision of the ornamentation. The acanthus leaf is divided into distinct parts and these are likewise subdivided into lobes of similar form. Arabesque ornamentation repeats the continuous leading forms in the interlaced delicate elements. etc.

76. German Renaissance.

It is not necessary to trace this principle in the remaining architectural styles. The German Renaissance is characterized by rich combinations of different forms more than by elegant proportions. On the remarkable facade of Otto-Heinrichs-Ban in the Castle of Heidelburg (FIg. 89), strict harmony of proportion between double windows and pilaster-order occurs, with all its diversity in form, and on the characteristic old Rathans in Zurich, depressed forms of windows and wall surfaces harmonize with the whole (Fig. 90).

77. Statements of Alberti.

If we review the Renaissance, the question arises, whether the architects of that period did not clearly state that law, so faithfully obeyed in practice. As Vitruvius is witness for antiquity, so is Leo Battista Alberti of Florence (died 1372) for the 15th century. This architect was the scientific founder of the Renaissance in Italy and expressed the leading idea in another manner, though easily intelligible. The beginning of his work "De Re Edificatoria" is a chapter on "Lineamenta". This requires parts of the structure to correspond to each other in angles and lines, which is to be attained by establishing angles and lines of fixed direction and combinations. Book VI, Chap.5, gives a description of a good design ending with the words: "All things must be adjusted to fixed angles by parallel lines". (Alberti's facade of Rucellai Palace, Fig. 77). Lines and angles drawn beforehand are therefore a means of obtaining proportional forms. In this way was obtained that "Rythm of the Masses," in which Burckhardt, most thoroughly acquainted with the Renaissance finds the art idea of the Cinque Cento period.

78. Architecture of Modern Period.

If we direct our attention to masterpieces of modern architecture, these also confirm what we found in the Antique and traced through the Mediaeval period. We mention the facades of Main Guard-House and of Museum at Berlin, both by Schinkel (Fig. 91), Old Pinacothek and Propyleum in Mun-

ich by Klenze (Fig. 92), leaving an analysis of these buildings to the reader. In the last example, two systems of similarity are to be distinguished; the upper stories of the towers are treated similarly to the entrance portico, and the doorways are analgous to the entire towers. The rule is so evident and so general, that in innumerable modern residences, facades are subdivided according to similarity of forms. A group of windows or a richly treated portion of the facade usually repeats the main form, the form of a window corresponds to the portion of the facade to which it belongs, etc. By a correct feeling, in framing copper plate engravings, etc., margins on the ends are made wider than those on the sides, or in ornamentation of title-pages, the decoration encloses a form similar to that of the entire page.

Chapter VI. Influence of Perspective upon Proportions.

79. Perspective.

The dimensions of a building change their respective ratios in perspective according to the point of view. Therefore fixed numerical ratios between all three space dimensions of the object can never be determined at once by the eye, though the harmony of a building is not expressed in its geometrical projections alone, but perspective as well. This opposes the assumption that harmony depends on simple numerical ratios and confirms the theory of analogy and similarity of forms. These also occur in the foreshortened view. Since this is a comparison of forms, which lie in the same or in parallel planes, these parallel dimensions are foreshortened equally within certain limits. In greater foreshortening of a facade, if widths and heights of parts are compared, the eye no longer recognizes even great differences, and the perspective view then exhibits approximate similarity of the parts to the whole, which does not in reality exist. The facade then possesses harmony when foreshortened, which is wanting in a front view, a phenomenon not infrequently observed. Vertical divisions are least changed in perspective; ratios of divisions in the height to each other, and their repetition in subordinate members appear most plainly in strongly foreshortened facades.

80. Theory of Similarity.

Since all objects may appear in perspective, a glance at perspective from the stand-point of the theory of similarity may be in place. Two general and well known phenomena are important:

1. A uniform series of equal intervals changes into a series of continually decreasing intervals.
2. Similar objects, repeated beyond each other and similarly located, are geometrically similar forms.

The beauty of the unifrom series is generally based on this property of its perspective appearance, when the divisions are so arranged, that approximately a : b :: b : c ::d, etc. (Double ratio of New Geometry). All other series, like those in periods or ~~groups~~, do not possess this beauty; for relations of two successive parts are confused in perspective. Hence monumental art always prefers a series uniformly continued in a straight or curved line. An important part is played in interiors, where these continued equal intervals exist in connection with a repetition of the cross section of the room in continually lessening dimensions. Space effect of a passage between columns, a vaulted hall, or the interior of a church, is more imposing, the further these repetitions of similar figures are continued. It is conceivable that our eyes have become so accustomed to regard equal figures as nearly similar, that even if a figure be repeated at an actually reduced scale, this agreement is at once recognized and an impression of harmony thereby created.

Final Considerations.

81. Proportions in Organic Nature.

When such a law is manifested in diversity of appearance, one must seek its basis. Let us attempt to penetrate further into the mystery. A prominent writer on Esthetics has said: "Sculpture is an imitation of human, and Architecture is an imitation of Plant forms." Inorganic nature supplies geometrical elements, and organic nature affords in plants, especially in the growth of trees, a model or a repetition of the primary form in the individual parts, the law of similarity and proportion. The entire form of the tree reappears in the branch; it even frequently appears in the form of the leaf or of the fruit. This repetition in plants results from growth, the first delicate twigs increasing to boughs and the germ becoming a complete organism. The completed building may be termed an organism. The whole grows out of a typical form and develops into numerous variations.

But another reason for a pleasing effect is based on the activity of the mind and consists in composing an image of the whole from views at different stand-points. The simpler the relation of the parts to each other, and the more frequently they are repeated, the more readily and willingly does the eye follow the lines, and the more easily is the internal intellectual image constructed. Mere similarity of form without variations and contrasts are justly found monotonous and wearisome. This requires this law to be supplemented by contrast, and contrast is to be strengthened by proportion. Contrast without harmony is disturbing and only appears irritating or even ridiculous.

82. Harmony.

The esthetic judgement of the eye is satisfied by similarity in variety. Is not the same true of the esthetic judgement of the ear? What is rhyme, on which is based the charm of modern poetry, but a similarity of sound, which cannot become identity, and which pleases even in its complications by its diversity and changes? We recognize rhyme in architecture as well. Similar rules are prescribed for harmony in music. It is everywhere a common conception and expression to designate the beautiful in sound and in form. Harmony in architecture is simply an analogy of the parts to the whole, as stated by Vitruvius. No rule of art compensates for lack of genius. Diligent use of the rhyming dictionary never made a poet; but a poet must carefully observe the rules of rhyme. Thus, knowledge of the law laid down here will never make an architect. But it will aid talent to shorten the course of experiment and to guard it from error. It may be termed a proper limit within which genius must work, in order to produce results that satisfy esthetic feeling and which may be justified to an inquiring mind.